

Preliminary Draft - Do Not Cite or Quote

ATTACHMENT 9

Summary of Growth Methodology for Agricultural Categories (From a 2001 Study by Pechan and Associates)

Forecasting Growth

Pechan relied on the forecasts of Regional Economic Models Inc. (REMI) for specific categories to develop its growth factors. REMI uses its model to forecast future trends of these categories based in their interaction with the California economy. The REMI model outputs only a limited number of these forecasted categories (those that have strong economic ties) and from these, Pechan attempted to find those that best fit the historical trends of the various emission categories in the Air Resources Board (ARB) inventory. These REMI output categories are called “Growth Surrogates” when used by Pechan in this way, as it is assumed that the inventory category will behave in a similar fashion to the surrogate assigned it when determining future growth.

Pechan ran a detailed, statistical analysis of the categories in the ARB database using historical trends (1986-1998) in an attempt to match these historic trends with surrogate trends from the REMI output. Those REMI surrogates that best fit each inventory category were assigned as that inventory category’s growth surrogate. If no suitable REMI surrogate could be found, one that matched a given inventory category well enough, then Pechan indicated such and usually went with a default of No Growth for that category, deferring to ARB to come up with its own growth surrogate if ARB felt a No Growth assignment was in error for that category.

Growth Surrogate Assignments

The attached spreadsheet details the growth surrogates used by ARB in forecasting the agricultural related inventory categories presented. The growth surrogate abbreviations are detailed here.

SIC/Fuel Adjusted Surrogates

Those surrogates beginning with SIC indicate that either the economic output (in dollars) or the employment in that SIC sector was used as a surrogate for future growth, with the potential for additional adjustment using fuel use trends as applicable.

Those SIC surrogates ending with (out) indicate that the category is grown only using the economic output (in dollars) for that SIC sector. Those SIC surrogates ending with (emp) indicate that the category is grown only using the employment trend for that SIC sector. If the SIC surrogate ends in one of the following letter-number codes (C5, I7, I21, I31, I32, I35 or I37) then that category was grown using the economic output (in dollars) for that SIC sector adjusted by the fuel use of that sector. The fuel used for the adjustment is indicated by the letter-number code in the table below:

C5 adjusted by Commercial Natural Gas
I7 adjusted by Food Associated Natural Gas
I21 adjusted by Other Manufacturing Residual Oil
I31 adjusted by Total Industrial Distillate Oil
I32 adjusted by Total Industrial LPG
I35 adjusted by Total Industrial Natural Gas
I37 adjusted by Total Industrial Renewables

Category Surrogates

Pechan assigned special growth trends to some categories. They focused on 50 of the larger ARB inventory categories statewide and assigned them special detail. These are listed here, taken directly from the Pechan Report (Pechan Report No. 01.02.004/9425.000).

Category 07. CES 83550 - Agricultural Pesticides, Methyl Bromide

ARB provided Pechan with a file developed by the Department of Pesticide Regulation (DPR) <Lerch, 2000a>. This file contains 1990-1998 process rates and total organic gas and ROG emissions for all four agricultural/structural pesticide categories in section 6.4 of ARB's Methods Manual at the Air Basin/District/county level. The DPR has only required full reporting of pesticide use since 1990; since 1970, DPR has compiled data from all pesticides used by commercial pest control operators and restricted material applications from farmers (i.e., criteria for restricted material designation includes harm to public health, farm workers, and others). DPR has published annual reports on these data since 1971. These tabular reports include the pounds applied and the number of acres or other units treated. Pechan compiled the pre-1990 DPR data, but determined that these data should not be used as surrogate growth data because they are not comparable to data in later years due to the significant change in reporting requirements and because of some anomalous changes in year-to-year values. (It should be noted that the DPR suggested that there may be gross errors in these data as they did not quality assure the pre-1990 data that were reported to them).

DPR staff has recommended to ARB that they incorporate the following assumptions into their forecasts of the two methyl bromide source categories to reflect the impact of the Montreal Protocol: (1) for Agricultural Pesticides-Methyl Bromide (CES 83550), the source category should grow through 2001, then be reduced to one-third of the 1990 value by year 2010; and (2) for Structural Pesticides-Methyl Bromide (CES 83576), the source category should be reduced to zero by the year 2005.

Pechan developed regression analyses of the 1990-1998 DPR data for this source category with a dozen variables (e.g., output and employment in farm sector; output and employment in food manufacturing sector), but was unable to

identify a successful correlation with any of these variables. Based on consultation with the ARB Contract Manager, Pechan used county-level Farm output as the surrogate growth indicator for pre-1990 trends in this category. Output in the Farm sector was used because of the strong historical correlation between agricultural non-methyl bromide use and this indicator. For 1990-1998, Pechan used actual Air Basin/District/county estimates of the amount of methyl bromide applied as reported by the California DPR. Pechan forecasted this emissions activity based on the DPR's assumptions. Specifically, Pechan grew the 1998 DPR estimates through 2001 using the county-level change in Farm sector output obtained from REMI's "best estimate" forecast. Pechan then estimated post-2001 values, by reducing the 2001 estimates so that by the year 2010, state-level agricultural methyl bromide is reported as one-third of the 1990 value. Pechan assumed no change in agricultural methyl bromide use after 2010. Pechan developed pre-1990 estimates by applying the county-level trends in Farm output to the 1990 DPR data.

[Note that ARB also provided Pechan with 1990-1998 DPR data on structural use of methyl bromide. ARB stated that Pechan should assume that structural use of methyl bromide (CES 83576) should be reduced to zero by year 2005. Pechan did not try to collect pre-1990 data for this category, as it is not one of the categories identified for detailed review. To back-cast this category, however, Pechan developed a regression equation based on the state-level 1990-1998 DPR data. Nonresidential fixed investment and population were identified as statistically correlated with this emissions activity (adjusted $r^2 = 0.979$, t -statistics of 10.68 and -10.27, respectively). However, this equation resulted in unreasonably large pre-1990 values. The reason for this result is the uncharacteristically large decline reported between 1990 and 1998 in structural use of methyl bromide. The two explanations for this dramatic decline are the tightened pesticide use reporting requirements that went into effect in 1990, and the impact of the Montreal Protocol. Because of the data anomalies resulting from the implementation of the regression-based approach, Pechan developed pre-1990 growth surrogate data for this category based on the county-level trend in non-residential fixed investment as reported by REMI. Pechan used this variable because the regression analysis indicated that it was the most strongly correlated with the DPR emissions activity data. Pechan developed post-1998 activity for this category by reducing the 1998 DPR estimates to zero in 2005 using a constant rate of decline.]

Category 08. CES 83568 - Agricultural Pesticides, Non-Methyl Bromide

As described above for CES 83550, Pechan obtained DPR non-methyl bromide agricultural use data for 1990-1998 from ARB and compiled 1970-1989 use data from the DPR. The pre-1990 DPR estimates are very different from the estimates from 1990 due to reporting requirement changes (improvements in pesticide use reporting coverage). Because of this inconsistency, Pechan did not use the pre-1990 DPR data in this effort. Based on a regression analysis, Pechan identified REMI Farm sector output data as statistically correlated with the application of

non-methyl bromide for agricultural use (adjusted $r^2 = 0.916$, t-statistic of 9.395). Pechan used the DPR Air Basin/District/county pesticide use data for the 1990-1998 growth surrogate data for this category. Pechan used county-level REMI Farm sector output data in the equation identified from the regression analysis in back casting and forecasting growth surrogate data for this category.

[Note that ARB also provided Pechan with 1990-1998 DPR data on structural use of non-methyl bromide pesticides. Pechan did not try to collect pre-1990 data for this category, as it is not one of the 50 categories identified for detailed analysis; Pechan developed a regression equation based on the state-level 1990-1998 DPR data. Housing expenditures were identified as statistically correlated with this emissions activity (adjusted $r^2 = 0.658$, t-statistic of 4.051). Pechan used REMI estimates for this variable and the identified equation to estimate growth surrogate data for the category. However, the resulting data provided numerous unreasonably large values. Because of these data anomalies and due to the short time frame and relatively weak correlation identified from the regression analysis, Pechan did not use the regression-based approach to back-cast/forecast this category's growth surrogate data. Pechan instead directly used the county-level trend in housing expenditures as reported in REMI's "best estimate" model to develop pre-1990 and post-1998 estimates for this category.]

Category 31. CES 83998 - Agricultural Irrigation, IC Engines, Diesel/Distillate Oil (Food and Agricultural Processing)

Individual Air Districts have the responsibility for estimating emissions for this category. Pechan assumes that the emissions activity for this category is based on the amount of distillate oil consumed by IC engines used in providing irrigation for agriculture. Pechan used REMI Farm sector output as the growth surrogate for this category for 1970-1996. For 1997-2020, Pechan used county-level REMI output data for the Farm sector adjusted for the change in National distillate fuel intensity for the Agricultural sector as developed from Annual Energy Outlook (AEO) data (Department of Energy (DOE), 1998). For 2021-2030, Pechan used the same approach as for 2000-2020, with the exception that the change in National distillate fuel intensity for the Agricultural sector was extrapolated from the 2000-2020 change in distillate fuel intensity reported in the AEO.

Category 32. CES 47233 - Fuel Combustion, Other, Liquid Fuel (Unspecified) (Food and Agricultural Processing)

Individual Air Districts have the responsibility for estimating emissions for this category. Pechan assumes that the emissions activity for this category is based on the total amount of food and agricultural processing-based petroleum-related fuel combustion. For 1970-1996, Pechan compiled REMI Farm sector output data as the growth surrogate for this source category. For 1997-2020, Pechan compiled county-level REMI output data for the Farm sector adjusted for the projected change in National petroleum energy intensity for the Agricultural sector. The National change in total petroleum intensity for the Agricultural sector was developed from projection data reported by the AEO (DOE, 1998). Pechan

used an analogous approach to develop growth surrogate data for 2021-2030, with the exception that the National change in Agricultural sector petroleum intensity was extrapolated from the 2000-2020 change in petroleum intensity.

Category 43. CES 47241 - Agricultural Burning-Prunings

Individual Air Districts have the responsibility for estimating emissions for this category. Pechan assumes that the emissions activity for this category is based on the amount of agricultural prunings burned represents the emissions activity for this source category. The “Open Burning” section of Environmental Protection Agency (EPA) *AP-42* document lists emission factors for the following orchard crops: almond, apple, apricot, avocado, cherry, citrus (orange, lemon), date palm, fig, nectarine, olive, peach, pear, prune, walnut, and unspecified (EPA, 1999). Based on this information, Pechan compiled historical acreage data for the following CDFA commodity codes: 261999 (Almonds, All), 211999 (Apples, All), 217999 (Apricots, All), 221999 (Avocados, All), 213199 (Cherries, Sweet), 208059, 201119 (Oranges, Navel), 201519 (Oranges, Valencias), 201999 (Oranges, Unspecified), 204999 (Lemons, All), 224999 (Dates), 225999 (Figs, Dried), 218199 (Nectarines), 226999 (Olives), 212199 (Peaches, Freestone), 212399 (Peaches, Clingstone), 212999 (Peaches, Unspecified), 214199 (Pears, Bartlett), 214899 (Pears, Asian), 214999 (Pears, Unspecified), 215999 (Prunes, Dried), 263999 (Walnuts, English), and 265999 (Walnuts, Black). Pechan compiled these data from data provided by the California Department of Food and Agriculture (CDFA) (CDFA, 2000). After compiling harvested acreage data for these commodity codes, Pechan identified seven counties in ARB’s 1996 inventory with emissions for this category for which no CDFA acreage data are reported for the above crops. Based on this information, the ARB Contract Manager agreed that Pechan would use total harvested non-pasture crop acreage data to represent the growth surrogate data for this category rather than the acreage data for crops with related emission factors in EPA’s *AP-42* document.

Pechan compiled 1986-1998 county-level total non-pasture harvested acreage data from the CDFA. To identify potential growth surrogates for this category, Pechan regressed the state-level harvested acreage data against multiple variables, including employment and output in the following sectors: Meat Products; Dairy Products; Farm and Garden Machinery, Food Manufacturing, Agricultural Services; and Farm. Pechan also included population as a potential independent variable in the regression analysis. Based on this analysis, Pechan identified two variables providing the best statistical fit: population and employment in the Farm and Garden Machinery sector (adjusted $r^2 = 0.793$, t-statistics of -5.098 and 4.111, respectively). The negative coefficient for the population variable can be explained by crop acreage losses as urbanization takes place.

Pechan prepared the growth surrogate data for this category from the identified equation that related population and employment in the Farm and Garden Machinery sector to total non-pasture harvested acreage data.

Category 44. CES 47258 - Agricultural Burning-Field Crops

Individual Air Districts have the responsibility for estimating emissions for this category. Pechan assumes that the emissions activity for this category is based on the amount of agricultural field crops burned. EPA's *AP-42* document lists the following field crops with emission factors for agricultural burning: asparagus, alfalfa, barley, beans (red), corn, cotton, hay (wild), oats, pea, pineapple, rice straw, safflower, sorghum, sugar cane, wheat, and field crops, unspecified (EPA, 1999). Pechan compiled county-level 1986-1998 harvested acreage data from the CDFA for the following crop categories: 302199 (Asparagus, Fresh Mkt), 302299 (Asparagus, Proc), 302999 (Asparagus, Unspecified), 181999 (Hay, Alfalfa), 113944 (Barley Malting), 113995 (Barley, Feed), 113999 (Barley, Unspecified), 161717 (Beans, Red Kidney), 161722 (Beans, Sm Red), 111559 (Corn, White), 111991 (Corn for Grain), 111992 (Corn for Silage), 111998 (Corn, Crazy), 121219 (Cotton Lint, Upland), 121229 (Cotton Lint, Pima), 121299 (Cotton Lint, Unspec.), 188799 (Hay, Wild), 112999 (Oats for Grain), 361199 (Peas, Green Fr. Mkt.), 361299 (Peas, Green, Processing), 361999 (Peas, Green, Unspecified), 362999 (Peas, Cowpea & Blackeye), 394999 (Peas, Edible Pod), 198199 (Rice, Wild), 158269 (Safflower), 114991 (Sorghum, Grain), 114992 (Sorghum, Silage), 131999 (Sugarcane), 101999 (Wheat All), and 198999 (Field Crops, Unspec.). These data were compiled from data provided by the CDFA (CDFA, 2000). The total State acreage for these crops was regressed against 12 potential explanatory variables. The best equation was identified with population and employment in the Farm and Garden Machinery Equipment sector (adjusted $r^2 = 0.883$; t-statistics of -8.506 and 3.538, respectively). The negative coefficient for population can likely be explained by increased urbanization resulting in less acreage utilized for agricultural use.

Pechan used REMI population and Farm and Garden Machinery Equipment employment data in the equation described above to develop state-level factors to apply to the actual 1986 and 1998 acreage values. A review of the resulting estimates indicated near zero values by the year 2030. Because it is unclear that this assumption is reasonable, Pechan implemented a no growth assumption to represent the growth surrogate data for this category for all non-regression analysis years (i.e., all pre-1986 and post-1998 years); the regression output was used for 1986-1998.

Special Surrogates

The following are three special surrogates used by ARB, and Livestock is the only one among them developed by the ARB and local districts without Pechan consultation.

StructmethyI

This surrogate is derived using the DPR suggested formula that the emissions of methyl structural pesticides should be reduced to 0 by 2005. See Category 7 note.

Structnonmet

This surrogate is derived using forecasted, county level housing expenditures as detailed in the Category 8 note.

Livestock

Pechan could not find a suitable match to fit the livestock waste emissions category, so they assumed No Growth. ARB in conjunction with the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) developed a new growth surrogate to replace the No Growth specified by Pechan (see Attachment 7). For details on this surrogate contact Michael FitzGibbon (mfitzgib@arb.ca.gov).